Journal of the Society of Arts.

FRIDAY, APRIL 6, 1866.

Announcements by the Council.

Ordinary Meetings.

Wednesday Evenings, at Eight o'Clock :—

April 11.—"On the Piracy of Trade Marks." By E. M. Underdown, Esq., Barrister-at-Law.

April 18.—"On the Diseases of Meat as affecting the Health of the People." By Dr. Thudichum.

Cantor Lectures.

The following is the syllabus of a course of four lectures "On the Synthesis and Production of Organic Substances by Artificial Means, and the Applications which some of them receive in Manufactures," to be delivered by Dr. F. Crace Calvert, F.R.S., as follows :—

Lecture I.—Friday, April 13th.

"On the Synthesis of Organic Substances."

The direct formation of *acetylene* (the most illuminating compound of coal gas), of *formic acid* (the acid of ants), and of *alcohol* (spirits of wine) from mineral compounds. The transformation of *acetylene* into *olefiant* gas, of *formic acid* into *marsh gas* (fire-damp), of *alcohol* into *acetic* acid, and of these substances again into *benzol*, *phenol*, and *napthalin* (products obtained from coal tar), and of *marsh gas* into *acetylene* and *benzol*, &c., &c., &c.

Lecture II.—Friday, April 20th.

"On the Transformation of Neutral Substances."

On the transformation of *starch* into *cane* and *grape sugars*, and also *pectic acid* (with remarks on the ripening of fruits and the production of jellies). On the transformation of *sugar* into *alcohol*, *ether*, *aldehyde*, *acetic*, *formic*, *prussic*, *oxalic*, and *butyric acids* (the acid of rancid butter), and also the conversion of *sugar* into *mannite* (obtained also from manna), and into *lactic acid* (acid existing in the blood and flesh of animals, and also in sour milk).

Lecture III.—Friday, April 27th.

"On the Transformation of Organic Acids and Animal Substances."

The artificial production of *benzoic acid* (found in benzoin resin) from the essence of *bitter almonds* and from *coal tar* products, and its conversion into *hippuric acid* (found in the secretion of herbivorous animals); of *tartaric acid* (the acid characterising cream of tartar), from *sugar of milk* and from *succinic acid* (the acid obtainable from amber), and its decomposition into *oxalic* and *acetic* acids—On the transformation of *citric acid* (the acid of lemons and oranges) into *aconitic acid* (found in wolfsbane)—On the transformation of *malic acid* (which characterises the acid flavour of green gooseberries, apples, and rhubarb) into *fumaric acid* (the acid of common fumitory) and also into *equisetic acid* (the acid found in the marsh horsetail), and, lastly, into *asparagine* (the body found in asparagus and potatoes)—On the transformation of *uric*, *cyanuric*, and *cyanic* acids into *allantoin* (the substance found in the allantoid fluid of cows)—On the artificial production of *urea* (a substance which characterises the liquid secretions of man and of many other animals).

Lecture IV.—Friday, May 4th.

"On the Artificial Production of Aromatic Substances."

On the transformation of *salicine* (the bitter principle of the willow and poplar) into the essential oil of *meadow-sweet*, *coumarin*, and of the *tonquin-bean*—On *salicilic acid* and the artificial production of the fragrant essential oil of the *wintergreen*, or *gaultheria*—On the transformation of *indigo*, the *oil of potatoes*, and that of *camomile* into *valerianic acid* (the acid which characterises the odour of valerian-root; the berries of the common guelder-rose; the oil of the fish porpoise, and of certain kinds of cheese)—On the conversion of *essence of turpentine* into *camphor*; of the essential oil of *mustard* into that of *garlic*, &c., &c., &c.

The lectures will commence at eight o'clock, and are open to members, each of whom has the privilege of introducing one friend to each lecture. For this purpose a set of tickets is forwarded with this number of the *Journal*.

Art Workmanship Prizes for 1866-7.

The Council have decided to enlarge the basis on which artisans may compete for prizes for Art Workmanship, and have passed the following resolutions :—

Any producer will be at liberty to exhibit, either in his own name, or through his workmen, any work or works as specimens of good workmanship in the classes given below, provided that the work or works be accompanied with a statement of the name or names of the artisans who have executed their respective portions; and if the work or works be sufficiently meritorious to deserve them, extra prizes will be given to the artisans who have executed them.

Artisans may, if they think fit, exhibit works executed by them after other designs, in any of the above-mentioned classes. Such works may contain the whole or portions of the prescribed designs, and must be of a similar style and character. Competitors must specify the class in which they exhibit. Extra prizes will be awarded.

The works submitted must be delivered at the Society's House on or before the 22nd December, and will be exhibited at the Society's house, and afterwards at the South Kensington Museum. A selection of the best works will be made and sent to the Paris Exhibition of 1867.

The Classes will be as follows :—

FIRST DIVISION.

Works to be Executed from Prescribed Designs.

Class 1.—Carving in Marble, Stone, or Wood.
Class 2.—Repoussé Work in any Metal.
Class 3.—Hammered Work, in Iron, Brass, or Copper.
Class 4.—Carving in Ivory.
Class 5.—Chasing in Bronze.
Class 6.—Etching and Engraving on Metal—Niello Work.
Class 7.—Enamel Painting on Copper or Gold.
Class 8.—Painting on Porcelain.
Class 9.—Decorative Painting.
Class 10.—Inlays in Wood (Marquetry, or Buhl), Ivory or Metal.
Class 11.—Cameo Cutting.
Class 12.—Engraving on Glass.
Class 13.—Wall Mosaics.
Class 14.—Gem Engraving.
Class 15.—Die Sinking.
Class 16.—Glass Blowing.
Class 17.—Bookbinding and Leather Work.
Class 18.—Embroidery.
Class 19.—Illuminating.

SECOND DIVISION.

Works to be Executed without Prescribed Designs.

Class 20.—Modelling.
Class 21.—Wood Carving.

Except in Classes 1, 2, and 4, the subjects will remain as in the list already issued; but in Classes 1, 2, and 4, other subjects will be given, particulars of which will be duly announced.

Institutions.

The following Institution has been received into Union since the last announcement:—

Burrage-road Evening Classes, Plumstead-common, S.E.

Proceedings of the Society.

Seventeenth Ordinary Meeting.

Wednesday, April 4th, 1866; William Walker, Esq., in the chair.

The following candidates were proposed for election as members of the Society:—

Armstrong, Richard Baynes, King-street, Lancaster.
Ashbury, James, 27, Great George-street, S.W.
Austin, Stephen, Hertford.
Birley, Samuel, Ashford, Derbyshire.
Bryant, Wilberforce, Patent Safety Match Works, Fairfield, Bow, E.
Dutton, Francis S., F.R.G.S., Reform Club.
Fowler, Francis H., 32, Fleet-street, E.C.
Gossage, William, Widnes Soapery, near Warrington.
Gowland, G., 76, South Castle-street, Liverpool.
Holdsworth, Samuel, 54, Spencer-st., Clerkenwell, E.C.
Mander, Charles Benjamin, Varnish Works, Wolverhampton.
Middlemore, William, Holloway Head, Birmingham.
Patterson, W., jun., 2, Dover-place, Clifton, Bristol.
Penson, Richard Kyrke, Ferryside, Kidwelly.
Rowden, William T., Burrage-road Evening Classes, Plumstead, S.E.
Rüst, R. A., 8, Argyll-street, Regent-street, W.
Watkins, Charles A., 10, Greek-street, Soho, W.
Wood, J. W., Custom House, Harwich.

The following candidates were balloted for, and duly elected members of the Society:—

Baker, Rev. Charles, M.A., Tellisford, Somersetshire.
Chubb, Harry, 33, John-street, Bedford-row, W.C.
Hunt, John Hammond, 20, Cannon-street West, E.C.
Loy, William T., Dingwall-road, Croydon, S.
Myers, William Henry, 302, Whitechapel-road, E.
Webb, John Stephen, 34, Cadogan-place, S.W.
Whitelaw, John, Dunfermline.

The Paper read was—

THE MANUFACTURE OF SUGAR, AND THE MACHINERY EMPLOYED FOR COLONIAL AND HOME PURPOSES.

By N. P. Burgh, Esq.

The importance of sugar cannot be overrated, when we consider the enormous increase of this dietetic article all over the world. In the United Kingdom alone, the consumption is now close upon half a million tons yearly, or over 42 lbs. per head to the population, whilst in America India, Australia, and other countries, the consumption is nearly as large and yearly increasing. Mr. P. L. Simmonds, in his new edition of Waterston's *Cyclopedia of Commerce*, published in 1863, states, that the consumption of sugar in the world might be roughly estimated at 2½ million tons, of which the United Kingdom uses 462,500 tons, the rest of Europe about as much, and the United States nearly 400,000 tons. The production of cane sugar is perhaps only about 1½ million tons; but maple sugar 40,000 tons, date sugar, 100,000 tons, beet-root sugar, 500,000 tons, and potato sugar make up the deficiency. The following estimate of the production of cane sugar, in 1860, is given by Mr. Simmonds, and it is probably approximately near the mark at the present time, as regards the total; for while there has been an increase in production, in many quarters, to the extent of 25 per cent., in the United States and some other countries there has been a falling off.

Production of cane sugar in 1860:—

	Tons.
Brazil	100,000
United States	114,000
Cuba	300,000
Porto Rico	50,000
French West Indies	65,000
Danish West Indies	7,500
Dutch West Indies	15,000
British West Indies	200,000
East Indies, Siam, China, &c.	300,000
Mauritius	122,000
Java	100,000
Manilla	25,000
Natal	4,000
Bourbon, Central America Peru, Sandwich Isles, and others	10,000
Total	1,412,500

We have no data to fall back upon of the number of sugar works in all the producing countries (and it would be useless to furnish the data for a few), nor of the character of the machinery and plant used; but the extent of the production shown in the figures quoted will convey an idea of the great interests at stake, and the large capital that must be embarked. Less perhaps is known generally by the public, and even many specially interested, of sugar machinery than of any other description of machinery in use.

It would seem hitherto to have been the policy of makers to surround their workshops with mystery, and to publish nothing whatever in the shape of information. In the several International Exhibitions, sugar machinery has always been very poorly represented, and planters, merchants, and refiners have had few opportunities of inspecting improvements. In the Jury Report on Food, at the last London Exhibition (1862), it was observed that the production of sugar was more largely illustrated than it was in 1851, but there had been but little marked improvement in its manufacture during the eleven years which had elapsed since the former Exhibition, notwithstanding that the use of the turbine or centrifugal process, whereby the molasses is more quickly separated from the crystallizable sugar, had been much introduced; and it was added with regret that very little if any information had been given from any of the different countries, on the subject of sugar manufacture. Without attending to the simple processes of obtaining maple sugar in North America, to the manufacture of sugar from the Sorghum as carried on in the United States, to the production of date sugar in India, or the more extensive manufacture of sugar from beetroot on the Continent, I shall restrict myself to noticing the machinery in use for extracting sugar from the juice of the cane, and for subsequently refining the raw sugar. I need not at all allude to the cultivation, for this has been frequently treated of; chemical investigation has also been brought to bear with great advantage in the several processes of manufacture; and I may direct attention to the important published treatises, "Researches on the Juice of the Sugar Cane and the Modifications it undergoes during Manufacture," by Dr. Icery, President of the Chamber of Agriculture, Mauritius, a translation of

which is now in course of publication in Mr. Simmonds' Journal the *Technologist*, and the valuable chemical researches contained in the essay on the "Cultivation of the Sugar Cane in Cuba," by Don Alvaro Reynoso, published at Madrid, by the Spanish Government, last year.

The amount of sugar machinery exhibited in the International Exhibitions of 1851 and 1862 consisted simply of mills, open evaporating pans, vacuum pans, and centrifugal machines, being, in fact, an illustration of the shadow of the reality required. The improvements made in sugar machinery have been but poorly represented at all times. This may perhaps be partially attributed to the want of public interest in the matter. Engineers also seemed afraid to instruct each other. In fact, when I published my "Treatise on Sugar Machinery," in 1863, many of my friends predicted my total annihilation by those in power. On the contrary, however, the work in question has not deteriorated my position, but rather improved it. I was not, however, the first in the field, for in 1850 Mr. J. A. Leon gained the prize gold medal offered, through this Society, by H.R.H. the Prince Consort, who has ever promoted the advance of science and art. The prize essay was—"The Art of Manufacturing and Refining Sugar." Later than this, in the Society's *Journal* for October 13, 1865 (p. 717), an allusion is made by Dr. Calvert to a new process of preserving the cane juice by congelation, termed "concreting." This is the invention of Mr. A. Fryer, of the firm of Fryer, Benson, and Foster, of Manchester. From communication with those gentlemen, I am led to believe a great desideratum has been gained, viz., a dry goods for transit without waste. This will be better appreciated when it is known that in one voyage from the colonies the amount of drainage per hogshead is, for raw sugar, 10 lbs., and for refined, 2 lbs. to 3 lbs. I am told, also, by credited authorities, this drainage is too often deemed useless.

I now propose to bring under notice the colonial and home manufacture of sugar, together with the machinery employed.

Colonial Manufacture.

With reference to the manufacture or the production of sugar from the cane, the commencement of the process in some colonies is a formal ceremony. Mr. Reed, in his late work "On Sugar," informs us that "there is much bustle in the sugar-house when crop time arrives; it wears a very animated appearance. The whole concern is overhauled; water is being drawn and stored for constant use in grinding time, cleanliness being the very keystone of success in colonial sugar operations. Engine and mill are being taken to pieces and carefully examined; kettles are cleansed; walls are whitewashed, and the molasses tanks cleansed from thousands of dead rats and cockroaches. At length, all having been arranged, the engineer informs the overseer, or 'mayoral' as he is called, that grinding may commence. This announcement is made with all solemnity; and a solemn one it is, for the operation of grinding having once commenced, it must not be intermitted. The mayoral has some time ago examined all the cane patches, and arranged in his own mind the order in which they shall be cut. A day is appointed for beginning work, and before it comes the season is one of amusement. The negroes sleep, dance, or beat the gumbo, as may seem to each best. The whites probably gamble, or pass the time at the *baile* or ball. The morning of operations at length comes. With daybreak the mayoral tells off the gangs, each slave armed with a machéte, or cane knife. A string of bullock carts follows the gangs to the fields, to bring the cane to the mill immediately when cut. A negro mayoral, or overseer, heads each gang; he is armed with a machéte more ornamental than those of the rest, and, moreover, carries a stout whip, the better to enforce his authority." Each gang proceeds to its allotted portion, for the purpose of separating the cane from the stalk. The cutting is close to the surface of the ground, as the lower portion of the cane contains the greatest amount of saccharine. Each cane is singly handled, both for cutting and trimming, and divided into lengths of about two to three feet. The trimmed portions are gathered indiscriminately, in some cases, into the wains and carts, and thus transmitted to the receiving shed near the mill-house. The next stage of the process is "crushing the cane." Many schemes have been tried to supersede the general mode, which is by rollers.

In 1853, a patent was taken out for "cutting the cane into short lengths, and then reducing it to sawdust;" after which the cane is subjected to the action of steam, preparatory to compression—this latter attained by hydrostatic pressure. Other processes have been invented, such as to cut the cane into slices, soak them in water of a given temperature, and complete by evaporation. A third idea has been to slice the cane and dry it, for the purpose of transit; after which the soaking and evaporating processes are carried out. From my own experience, and from information imparted by sugar planters, I feel no hesitation in stating the rolling or crushing process to be the most practicable yet brought into operation.

The cane is now presumed to be in the shed before alluded to; each portion is laid on the carrier or feed table of the mill, not at random, but in rows longitudinally, or at right angles with the roll's length. The mill generally adopted is the three-roll kind, to which I shall directly advert. The top and inside rolls grip the cane, and thus the parts in contact become propelling and crushing at the same time. The outside and top rolls grip the partially crushed cane, and thus complete the process. The term given to the crushed cane stalk, in colonial language, is either "bagass or megass," but the latter is mostly used in England. The megass presents itself in flat portions of about three to four feet in length, principally used by the planter as fuel. This is much to be wondered at, when it is remembered that the ground producing the cane is actually thus robbed. The cane should be returned to the soil, as the natural manure, instead of having recourse to artificial and expensive kinds. The planter may urge, in answer to this, that wood is scarce, and coal inaccessible; and he has thus to choose between two evils, "either to purchase manure or fuel," and he generally prefers the former. I have not the least doubt, however, that in proportion to the better means of colonial transit, megass will in future be correctly applied. Its money value as a manure, in proportion to coal for fuel, may be said to be about equal. There are, however, divided opinions on this subject, but I think it will be found that the most competent authorities will be unanimous on one point, that megass is adapted for manure more naturally than for fuel artificially.

I may state that the furnaces required for megass are larger than when adapted for coal; and for this reason the ordinary egg-end boiler is often used, the fire-place being outside the shell, instead of within the same, as with the Cornish or internal type. In my own practice I use a long-flued boiler, in preference to the egg-end or tubular kind, having found it to be more simple to manage than the latter, and more effective for evaporation than the former.

Having thus disposed of the cane, attention may now be given to the extract from the same. The liquor or juice is received into the bed-plate, and from thence runs into a tank located at the side or end of the mill, usually the latter. The colonial term given to the cane juice is "ching." The ching, after leaving the bed-plate, should be pumped into the boiling utensils. These vessels are heated by steam or fire. In some colonies the latter is still advocated, while in others science has been recognized and steam introduced. The primitive mode of evaporation is by a series of concave boilers, each less in depth than the preceding one. This arrangement is termed the "train." In other examples longitudinal

vessels are used, secured end to end, flues extending underneath for the entire length; this arrangement is termed a "batterie." The disadvantages of open pans are that the atmosphere injures the liquor, while at the same time the increased temperature carbonizes the sugar, and produces molasses, &c. Since engineers have turned their attention to sugar machinery great improvements have been made. Heating by fire is always uncertain; the temperature may be raised too high, without any immediate check.

The native boilers, as a rule, are not famed for their high conception of their duties; they rather work at hazard than by understanding, and fall into some amusing as well as disastrous mistakes. Many anecdotes can be related proving the truth of these remarks. In an excellent periodical, the *Colonial Magazine*, for January, 1849, edited by Mr. Simmonds, there is an article "On the Establishment of Central Sugar Works in the British Sugar Colonies," by Mr. John Biggs, Colonial civil engineer. He states:—

"In 1844, when in Antigua, to see if the negro boiler was observant of the changes in cane-juice, as well as to ascertain what idea he had of it, I called the attention of the head boiler to the fact that the two first skips of sugar in the morning contained a much larger quantity of molasses than the skips boiled later in the day, to see how he would account for it. He said:—'Cause of too much molasses in the sugar is liquor too long on the fire; him stew from sundown to sun up—this make molasses. Sugar boil late in the day, with good fire, him no have time to make much molasses.' Poor fellow! he had no idea the juice was forming that subtle and formidable enemy to crystallization, or that if he had continued slow boiling for a few hours, and added a few pounds of *tous les mois*, as the ladies do isinglass to set the material, he would have made his master a hogshead of jelly of some kind of fruit, the particular description cannot be stated, as it rather partakes of a species of lottery. However, this shows the necessity of continuous work in the manufacture of sugar, as every interruption to the process causes a serious loss, by the conversion of a very large portion of the crystallisable part of the syrup into molasses; it is this continuous work, even on the largest and best conducted estates, which it is impossible for the sugar planter to effect, nor can it ever be accomplished but by the aid of central works, where power and capital will effect this desirable object."

Mr. Reed (already alluded to) gives a lucid account of the primitive mode of evaporation, and the arrangement of the train, defecators, and clarifiers. He says:—

"The series of open pans in which the evaporation is conducted, taken collectively, is called 'the train,' the setting of which is subject to variation, though the most general arrangement is as follows: beginning with the flue, which is straight, and from forty to fifty feet long, one extremity of it ends in the great chimney, the other communicates with the furnace grate and ash-pit. The flue runs along one of the side walls of the sugar-house, the mouth of the furnace being outside. The arrangement of the flue is such that the pans when set rise about two feet above the level of the floor. The arrangement of the pans is linear, corresponding with the flue, all except the two defecators which stand side by side. In order to heat these, the flue before reaching them is split into three channels, one passing between the two defecators, one on each external side. Dampers are so arranged, that the fire may be turned aside from either flue at pleasure, on the instant; this being necessary, inasmuch as when a crust of vegetable impurity has formed, any prolongation of heat would break it up, and thus prevent its removal by skimming. On the proper setting and efficient management of the defecators depends the success of future operations.

"Next come the clarifiers, two iron pans set in brick-work. The second clarifier is a little smaller than the first, to allow for shrinkage of juice by evaporation. After the clarifiers come the evaporators, the first of which is set deep in brickwork, and its size is increased by an upper flange, thus giving room for the copious scum thrown up as the operation progresses. Lastly, and directly over the furnace, where, consequently, the heat is greatest, comes the "*tache*" or teache, arranged exactly like the preceding vessel, but somewhat smaller.

"This description having been given, let us now assume the train at work. Communicating with the juice-tank is a moveable gutter, which, being directed to each pan in succession, charges them with juice. The fire is now lighted, and the train is said to be started. So soon as the juice has warmed up a little, a portion of cream of lime is added, cream of lime being a suspension of lime in water, hence it is stronger than lime-water, which is an actual solution of lime. This cream of lime, called "*temper*," is added according to the sugar master's judgment. He is now, in Cuba, usually guided by the evidence of reddened litmus paper, just as a laboratory chemist would be guided. The object in adding lime is not merely to neutralize vegetable acid, a purpose for which carbonate of lime would be as effectual, and would at the same time be unattended with the danger to which the operator exposes his saccharine juice if he adds a large excess of lime. The special effect which lime has in this operation, as compared with carbonate of lime or chalk, is that of coagulating the vegetable albumen present in cane-juice; bringing it to the surface, whence it is removed in the condition of scum. As the heat rises this scum increases, and negroes standing by remove it with a skimmer. The pan nearest the furnace of course boils first, but ebullition soon commences all along the train. As the juice diminishes in the teache, or striking pan, it is supplied by ladling from the next vessel, or evaporator. This, in turn, receives juice from the second clarifier, to which the first clarifier ministers, this being supplied from the defecator. In this manner the train is started; but, inasmuch as the pans were all empty at the beginning, the juice has had no regular defecation; the first strike, therefore does not commonly turn out well. Neither of the defecators has yet come into play, but one of them is now filled from the receiver. Whilst filling, the sugar master tests the juice with litmus paper. This paper is blue, and the blueness changes to red more or less pronounced on coming into contact with any acid. Sugar-cane juice is always acid more or less, and it would be desirable if possible to neutralize the acid absolutely. The Cuba sugar master never attempts this; he knowing from experience that a slight excess of acid is preferable to an equivalent excess of lime. He adds cream of lime, therefore, not until the paper reddened by cane-juice changes back to blue again, but until the redness fades back to a faint rose colour. Juice being treated up to this point only requires heat and rest to bring the albumen and many other impurities up to the surface. The defecators are so arranged, that after the train is once started one is always full and the other empty: the latter being cleaned out.

"A train being once started, it goes on night and day, with the occasional rest of a day now and then to wash up, clear out the juice tanks and gutters, and effect such repairs as may be necessary. During these intermissions the negroes have a holiday, which they usually devote to sleep.

"A few old hands are usually attached to every Cuban sugar estate, who know as much about boiling as any sugar master—a great deal more, perhaps, than a newly-appointed sugar master, a stranger to some particular battery. The diplomacy that then takes place between Sambo and the master is edifying. Some old negro, who may have worked on the estate for twenty years, and who knows all about this particular battery, goes to the teache, when—taking a little of the syrup between his finger and thumb—he draws it out in a thread, and infers from the appearance of the latter that the juice has been boiled enough. Meanwhile the sugar master is away, though accessible, smoking his cigarette. Sambo tells him the skip is ready; but it would never do for the

sugar master to seem to be taught by Sambo. He knows that a few moments will make no practical difference, so he pulls out his watch, and affects to look with much edifying mystery at the dial. At length he lets Sancho, or Pedro, adjust the gutters leading from the teache to the cooler ten feet away, and the skip of emptying of the teache is effected."

The present mode of evaporation is by steam clarifiers. There are generally three to each mill. The ching is pumped into a tank, located above the clarifiers; in other cases direct into the latter. The operation of boiling or heating is this: Presume the ching in the clarifiers; steam is turned on, which circulates through the worm and surrounds the bottom, the latter being encircled by a jacket. When the temperature has reached to 130° to 140°, milk of lime is added in the proportion of about two or three ounces to 100 gallons of ching, which is gently stirred to mix the compounds; it may be added that the use of the lime especially is to prevent fermentation. The temperature is now presumed to reach nearly boiling point, or 205°. The scum on the surface will now break and disclose a white froth underneath. The increase of temperature can be suddenly checked by closing the supply steam-valve, and the liquor remaining dormant for 10 or 15 minutes, is ready for drawing off. It will thus be seen the advantages, of regulating the required temperature and the absence of striking teaches and manipulation.

Instead of continuing the evaporation, the better process is to filter the liquor—as it is now termed. This is attained by a series of bags located in a casing directly underneath the clarifiers. The syrup enters these bags of a dark hue, and comes out considerably lightened in colour, leaving behind many impurities, not to be eradicated by evaporation alone. After filtering the syrup flows direct into a tank, having within it a steam worm to preserve the temperature, it being remembered that the grain of the sugar is not yet formed. Now this tank can either be used as an open boiler or evaporator, or merely as a receptacle between the bag filter and the boiling pan. The syrup has now to undergo a second stage of evaporation. Here science is too often pushed aside, and planters will adhere to open pans; although engineers point out the advantages of evaporation in vacuo, the planter still fancies the old process. It must be remembered that to granulate or produce the crystals in sugar, a low temperature is imperative. If the syrup is congealed by high temperature, it carbonises, and becomes discoloured, and what should be sugar is molasses, actually what is not in the cane naturally. The process of evaporation by the open pan is simply a matter of slowly reducing the quantity of syrup, or retaining the denser portion, by a given temperature. Now when boiling in vacuo, science lends its aid, and less time is occupied, with a certainty of producing the required density. The time occupied for boiling depends on the nature and quantity of the syrup, hence no rule can be given. Assume a final proof to be taken, and the sugar to be sufficiently granulated, the discharge valve is opened, and air admitted into the vacuum pan which accelerates the exit of the syrup.

The remainder of the process depends on the class of sugar to be sent into the market. Should "raw sugar" be required the liquid is further extracted by atmospheric means. These are of two kinds, and though widely different in construction, are alike in theory. The primitive mode is on the pneumatic principle. A tank-shaped vessel is fitted with a false bottom, perforated with minute holes, the actual bottom being of the ordinary kind. Now it is obvious that on exhausting the air between the two bottoms the atmosphere will act on the syrup, and the liquid portion be forced through the holes alluded to. The more simple and recent mode is by the centrifugal machine. This is simply a basket of wire and gauze-work, surrounded by a casing. The syrup is put into the basket, and a rotatory motion being given to the same, at a great velocity, say 800 to 1,000 revolutions per minute, the liquid in the syrup will be forced—by the atmosphere—through the basket into the casing. It will thus be understood that atmospheric means are employed in each case; the first is attained by the air pump, while the latter is produced by the vacuum caused from centrifugal force. The sugar, after being thus produced, is packed into bags or casks, and exported to the respective markets.

In the event of a more refined, or rather a purer, article being required, the filtering and granulating processes are again proceeded with. Now in this case bag filters are not available, for two reasons; first the texture of the material forming the bag can do no more than retain impurities, as before alluded to; secondly, the absorption of the colour is now requisite. To attain this desideratum animal charcoal has been introduced; hence to filter after the first granulation, charcoal filters are imperative. I may here add that the reason for filtering before granulation, is simply to reduce the colour as much as the impurities, it being known that the boiling or granulating process heightens the colour rather than reduces its hue.

The filters now alluded to are cylindrical vessels, fitted with perforated false bottoms, covered with flannel, to prevent choking. These cisterns are partially filled with animal charcoal, from eighteen inches to two feet from the top. The syrup passes direct through the charcoal, and by that simple mode is cleansed. The difference in the colour of the sugar before and after passing through the charcoal may be taken as brown brandy compared with the palest sherry.

The process of granulation is again requisite. Tanks are provided for the reception of the purified syrup, and from these the evaporating pans are supplied. At this stage of the process the planter, as before stated, is often inexorable as to the use of the vacuum pan, in place of the open kind. It must be said in justice, however, that the main cause is perhaps the increased outlay at the commencement; but in the face of this, a better article can be produced, and thus its value increased. Another argument, urged in favour of the open pan, is its simplicity of construction and management; and its non-liability for repair. The vacuum pan, on the other hand, is said to be complicated, requiring skilful attention, extra appendages, in the shape of air pumps, condenser, &c. The planter also pleads that he cannot always find skilled mechanics; hence the adoption of simple machinery producing an inferior quality of sugar is often preferred to a plant constructed on scientific principles, making a good article. The answer to these objections is a simple one,—perfect machinery and skilled attendants produce the best income in all cases of manufacture, and sugar in particular. We have full evidence of this in all examples of mechanical productions, as well as other classes of trade. The better article will produce the price in the market equivalent to its stage of perfection.

Assuming the sugar to have been granulated, it is next dried by the centrifugal machine, and then termed "refined sugar," not in the highest degree, but enough for general purposes, the next grade being "loaf sugar."

It may now be wondered at why the planter, having proceeded thus far in the production, does not complete the process—the answer, as a rule, will be much as before, adding, perhaps, the necessity of a quick return. True, in some instances, I know loaf sugar is produced in the colonies, but not often on the plantations, unless in a crude state.

I may, perhaps, be considered to advocate the abolition of "home refining;" such is not the case; I rather urge the planter—for his own benefit—what he does do, to do well, not in such an unfinished state as is now too often the case. I am aware, also, that there is not, in many colonies, good means of transit for machinery and material—hence, in some instances, the cause of the imperfect quality of the sugar.

Should the planter be in a position to produce loaf

sugar, the continued process will be thus:—Instead of drying the sugar, it is from the vacuum or open evaporating pan, let into the heater, a vessel semi-elliptical in elevation, and circular in plan. This pan is heated by steam, introduced within a casing or "jacket," the temperature of the sugar being thus increased or retained as requisite. The liquid, or rather semi-liquid sugar is now poured into moulds, these being either of a brick-like shape or cylindrical, the latter of unequal diameter at the extremities. The sugar is now by no means white, it is of a brown hue, and the removal of this colour, after setting, is the next stage. This is attained by drainage. After the sugar is congealed, and is in an almost solid state, a mixture of pure sugar and water is poured into the mould, and, by gravitation, sinks gradually through the loaf; the impurities which impart the colour, being dense, are effectually driven before the liquid alluded to. The primitive mode of purification was attained by "claying." Mr. Reed gives a truthful illustration of this:—

"To practice claying, it is necessary that the concentrated juice be at once turned into cones of metal or earthenware. Each cone is put upon its apex, which is hollow, the aperture being stopped either with a piece of wood purposely prepared, or, as is often done, a joint of cane. Sugar to be clayed is boiled a little stiffer than if intended for the cooler. Occasionally the concentrated juice, instead of being put into the cones at once, is turned into a wooden box running upon wheels, rather deep and long, in which it is agitated with a short oar for some time, until it has somewhat cooled, and crystals have begun to form; the box being then wheeled up close to the moulds, the latter are filled. In Cuba each mould contains from eighty to one hundred and twenty pounds of hot sugar. Crystallization is allowed to proceed in the moulds until the sugar-master considers the operation perfect. He then removes the plugs, when the molasses begins to drain away. The process of claying then commences. Clay being mixed into a sort of mortar with water is turned upon the base of each cone. The clay remains, but the water percolates through, carrying down many of the coloured impurities."

After sufficient time has elapsed for drainage each loaf is dried, either in the sun or in stoves suitably arranged, but mostly the latter. The sugar planter, by this additional process, can send "loaf sugar" into the market in such a state as he deems fit.

Sugar Refining House.

The process of refining the imported sugar will now be alluded to. The district ports mostly favoured in Great Britain are London, Bristol, Glasgow, and Greenock, the former and the latter being the principal. The class of sugar usually sent from the colonies is the raw or foot sugar. This is of a dark brown colour, interspersed with congealed molasses. Now, the art of the refiner is to supply to the market at home clean brown, moist, white moist, crystallised moist, and pure loaf sugar. The stages of the process in the three former examples of production are much alike, that for the last being an extension of the others. The sugar is imported in a crude state, being, in fact, congealed as quickly as possible for export, independently of the effect. Thus we have to pay, for our table-prepared sugar, the cost of two stages of manufacture; the first hasty and careless, and the second demanding care and attention from the result of the former. It has often been understood that raw sugar is actually sweeter than refined sugar, and that for culinary purposes the former is preferred. The fact actually resolves itself into this, that the presumed intensity of sweetness is not due to the impurity of the sugar, but rather to the quality of the same. Now, to describe the processes must be my next endeavour, commencing with that for producing "moist sugar."

Any one who has been at the east end of our metropolis must have noticed the tall buildings there located, seven to nine stories high, having windows to each floor. The general observer may naturally ask why are they so high? I will now explain. The less the sugar—when in a melted state—is agitated by compression, such as pumping or forcing, the better; hence gravitation, or a natural flow, is always preferred.

The sugar is exported from the colonies in casks, boxes, and bags, according to the custom of the exporters. On arriving at the sugar houses it is hoisted, by steam or manual power, to the "top floor," usually known by that name. This floor contains the sugar in its raw state, and the cases, bags, or casks are here cleansed, by steaming. Compartments termed "bins," are formed to hold the sugar until required further. On the second floor down are the blow-up pans, hence this room is often designated the "charging or blow-up room." Here the sugar is mixed with a syrup, composed of sugar and water, and steam is introduced to finally melt the whole. It may be added that each utensil will be fully described hereafter. The next or third floor is designated "the bag filter room." In this story the sugar, in a melted state, passes through bags, and leaves a certain amount of the impurities behind, termed "scum." The fourth floor is termed the cistern and warehouse room; here are stored the goods ready for the market, and cisterns or vessels to receive the melted sugar from the bag filters located above. The fifth story contains the animal charcoal cisterns, and the vacuum pan; this floor is generally known as the "pan room."

The sixth room is for the reception of the receiving cistern, containing the syrup after it has passed through the charcoal above. This room is also used as a warehouse, being generally on a level with the street or pavement. In this floor are the coolers to receive the melted sugar from the vacuum pan.

The basement is termed the "fill and machine room." Here the sugar from the coolers is dried in the centrifugal machines, afterwards put into hogsheads, and warehoused till sent into the market.

The next process which I shall allude to will be that for producing "loaf sugar." I must now state that the difference in this case from that just described commences in the sixth room. Here, as just alluded to, are the cisterns, but in the place of "coolers," "heaters" are required. In the former case, the density of the sugar from the pan was hastened, while in the latter, or the one in question, the temperature must be preserved, and, in some instances, increased, to produce the desired effect. When the granulation is attained in the vacuum pan, it is let into the heaters, and therein stirred, to effectually mix the grain. The sugar is now put into moulds of four kinds, the technicalities of which are bastards, lumps, tittlers, and loaves. The first weigh 56 lbs.; the second, 43 to 46 lbs.; the third, 20 to 35 lbs.; and the fourth, 3 to 18 lbs. I may here state that the loaves are becoming almost extinct in London. It will not be out of place to give the dimensions of the several moulds alluded to:—

a = the top diameter.
b = the bottom ditto.
c = the length.

Bastard = 56 lbs. in weight.
$a = 14\frac{3}{4}$ inches.
$b = 7\frac{1}{4}$ inches.
$c = 24\frac{3}{4}$ having an addition at the small end in the form of a cone 5 inches in length.

Lump = 44 lbs.
a = 12 inches.
$b = 6\frac{1}{2}$ inches.
$c = 24\frac{1}{4}$ inches.
Additional length, $5\frac{5}{8}$ inches.

Tittler = 28 lbs.
$a = 9\frac{5}{8}$ inches.
b = 4 inches.
c = 22 inches.
Additional length, $3\frac{3}{8}$ inches.

Loaf = 10 lbs.
a = $6\frac{7}{8}$ inches.
b = $2\frac{3}{4}$ inches.
c = $17\frac{5}{8}$.
Additional length, $3\frac{1}{8}$ inches.

The actual proportion can thus be readily understood.

To proceed with the description; the sugar is now presumed to be in the heater; while in a semi-liquid state it is put into the moulds, either by ladles or by troughs, but unfortunately more often the former. The drainage is now the next operation; the time occupied greatly depends on the moulds and the nature of the sugar. Bastards are the refuse of the whole, and consequently, being of a greater density, occupy more time in drainage.

The following is the actual result in a London sugar refinery. Bastards, 14 days to three weeks; lumps, 6 to 8 days; tittlers, 4 to 6 days; and loaves, 3 to 5 days.

The moulds are lifted by machinery from the filling-room to the drain rooms. Above the pan-room the bastard and lumps are located. The next floor contains the tittlers, the room above being for the loaves. In order to attain that pure whiteness so well known in loaf sugar, "magney" is required. This is a technical term given to a compound of the finest sugar and water, thoroughly mixed. A tank is provided for its reception, and each mould is supplied by a gutta percha tube, the quantity being regulated by a stop-cock. The sugar is now allowed to drain to the required state. The next process is to remove the sugar from the mould; this is attained by knocking the latter at the small end. The loaf is then trimmed with a knife at each end, to remove the coloured portions. In some instances mechanical means are used, termed shaping and nozing machines, the former being for the flat and the latter for the conical end. After the sugar is properly trimmed, each loaf, tittler, or lump, as the case may be, is wrapped in the well-known blue paper, and put into the drying stove. This is a room having racks on each side, spaced or pitched from two to three feet. At the bottom is a service of steam pipes, which heats the stove to a temperature of 130° to 145°. Each loaf is laid on its side, packed in tiers, four to six high, so that the heated air can pass freely through. The time required for drying is from three to five days. When complete the sugar is warehoused, and thence sent to the markets. I must add that the draining rooms are surrounded with steam pipes, at or near the floors, to preserve the requisite temperature for drainage.

The bastards, after being sufficiently drained (also, in most instances the lumps), are cut into small portions by a mill. This is an arrangement of revolving short knives, secured at right angles to the shafts, which latter are two in number, each having eight to ten knives. Below these shafts are two rollers, between which the sugar is passed; by this means the sugar can either be remelted and refined or sent into the market as moist sugar. Refiners in London generally make refined sugar on the first four days, the remainder of the week being devoted to lumps and bastards, the latter being the refuse of the days' work, together with the coarsest sugar. Having thus far briefly described the ordinary course of the colonial and home processes, I will now allude to the machinery employed for those purposes.

Colonial Machinery.

To enable a correct conception to be formed of the type of machinery required for the colonial produce, I will now describe each portion consecutively; before doing so however I will now run through the synopsis of the following requisitions. 1. Steam boilers. 2. Sugar-mill, engine, gearing, cane-carrier, and ching pump. 3. Clarifiers. 4. Bag filters. 5. Heating tanks, open evaporators, or vacuum pan, and, if the latter, engine and air-pumps. 6. Charcoal filters. 7. Centrifugal machines. 8. Tanks, moulds, scum press, coolers, or heaters, as may be required, condensing box, and expansion valve. 9. Charcoal furnace and washing apparatus. 10. Casks, cases, bags, trucks, and wains. The detailed description must be my next endeavour.

1. Boilers.—These are of two classes, cylindrical and tubular; the former is the most simple, while the latter will generate more steam proportionately. The planter should not choose complication, unless he has available means for repair, material, &c.; hence, in my own practice I always introduce the Cornish boiler (internally fired), as being the most durable and simple to manage. Boiler fittings should be as effective for the planter as possible, consisting of two lever safety valves, and a steam guage for the pressure of the steam, guage glass, and valves for the indication of the water, surface and bottom blow off, and feed relief valves, main steam stop valve, man hole, furnace, flue and mud doors, damper, fire bars, bridge, and Donkey feed pump.

2. Sugar Mills are now of one type only, with few exceptions, the three rolls being horizontally located in the frames. The principal portion to be considered by the engineer is the strength of the side frames, and the removal of the rolls without disarranging the former. Space will not permit my going into this matter in detail; suffice it to say that the planter has great cause to acknowledge the advantage of the present over past examples of sugar mills. The type of engine mostly adopted is the beam, for large mills; the horizontal and vertical for the lesser kind. In my own practice I prefer the horizontal high-pressure engine, with suitable spur-gearing, the largest wheel being, in all cases, under twelve feet in diameter. The cane-carrier is simply a series of rollers on which the cane is laid; it is obvious that on motion being given to the rollers, the cane will be propelled in the required direction. The ching pump receives its motion either from the top roll shaft or the gearing shaft, the latter being the preferable, as well as the later arrangement.

3. Clarifiers.—These are introduced to the planter to supersede the teache and battery heated by fire. The arrangement of the clarifier of late construction is a semicircular bottom, encased in one of larger proportional dimensions in depth than in diameter. A worm or coil of pipes is located in the bottom, extending nearly to the top, there being a light course of metal above the flanged connection. The steam passes through the worm, and from thence into the space between the bottom and jacket, and thus an almost double effect is attained. I may add that in some instances the worm is dispensed with, but I prefer its adoption. The jacket should always be fitted with safety, air, and steam valves, also a discharge plug, and a two way-valve in the bottom for the exit of the scum and liquor.

4. Bag or Bell Filters.—The casing is shaped as an ordinary box, having parallel sides and ends, the top being open. The bags are of canvas, open at the top, and secured to the bells with strong cord or wire. Each bag is enclosed in another, open at each end, to support the one containing the impurities. The bells are cylindrical portions, enlarged at the lower end, to sustain the grip of the bags. The bells are screwed into the plate placed in the casing for their reception. The liquor, on leaving the clarifiers, passes direct into the bags, through the bells alluded to. The casing should in all cases be provided with steam-tight doors and a steam jet valve, to retain the temperature of the filtering liquor.

5. Heating Tanks.—These are simply for the accumulation of the liquor in its passage from the bag-filter to the evaporating pan. A coil or worm of pipes is located in the bottom, steam being introduced to preserve the temperature of the liquor. Steam and discharge valves are suitably located to obtain the effect required.

Open Evaporating Pans.—It is difficult to point out any portion of the plant for a sugar plantation that has received more popular attention than these vessels. When the requirements are considered, this is not to be wondered at. The object sought after is the perfect evaporation of the water in the liquor at a given

temperature. Patents innumerable have been granted for this purpose, all the schemes professing to attain the same results. The prevailing idea amongst the advocates of the open system of evaporation is, that by constant agitation and exposing the heated liquor in thin films to the atmosphere, the desideratum is effected. Now to produce this effect, discs are mostly used; these revolving in the liquor retain some portion on their surfaces, and thus evaporation is greatly accelerated. The arrangement of the entire portion is generally thus: A vessel, either of a flat bottom or semicircular form, encloses one of less dimensions, thus a space between each is retained. The inner vessel is open at the top for its length and breadth; a shaft is centrally—of the width—supported on suitable bearings. Discs of thin metal are secured on the shaft in question; the diameter of these discs is a little less than that required to clear the inner surface of the pan. The syrup is put into the inner vessel to a given depth, and steam is introduced within the space alluded to. On motion being imparted to the shafts the discs will revolve and the heated liquor will adhere in thin portions to the surface, thus a great amount of the fluid is exposed to the atmosphere, while the remainder is being heated below. It may be added that the evaporation being thus effected is the cause for the various arrangements. In order to increase the heating surface worms or coils of pipes have been introduced within the pan, the steam from the worm surrounding the same as before. To produce greater evaporation than by plain discs those of a corrugated surface have been introduced. Not contented with this, inventors have proposed, and indeed made, hollow discs, filling them with steam or boiling water. Other proposals have been started, such as to dispense with the discs and evaporate in flat pans, worms, &c. Indeed, further than this, steam belts have been suggested, *i.e.* a hollow portion of thin metal, in the form of a belt, supported on rollers at each end. The cavity is filled with steam or water, as may be deemed consistent, and a fire below retains the temperature. The liquor flows on the upper portion of the belt at one end, and at the other is located a skimmer to retain the newly-formed sugar. I could describe many other devices, each claiming attention; but the principle in each case is the same as in those already alluded to.

Vacuum Pans.—The main consideration of the sugar boiler with the open pan is to evaporate below boiling point, or 212°, and even much below this temperature the sugars at a given stage will carbonise. Now, it is obvious that if the sugar or liquid of any kind be relieved from the pressure of the atmosphere, the boiling temperature will be in direct proportion to the vacuum obtained. For example, liquid boiling in an open pan is 212°, is acted on by a pressure of 15 lbs. on the square inch, but on enclosing the vessel and exhausting the air, the ebullition will be increased, while the temperature will be reduced from 120° to 126°, causing an absence of a pressure equivalent to 14.5 lbs. to 13lbs. on the square inch. I have known vacuum pans worked with an absence of 29.3 inches of mercury, or nearly a perfect vacuum attained. This, then, is the theory of the vacuum pan. I will now describe its external and internal arrangements. The form of the pan in elevation is similar to an ellipse; in some instances the lower portion is formed as a hyperbola, but the former is the most popular, simply because it will boil more effectually, while the latter will require two or three worms. The plan, in all cases, represents a circle. I may add that the primitive form was cylindrical, but this has been discarded long ago for the shapes alluded to. The pan is generally in three portions, the first being the casing or jacket; the second, the bottom inserted in the former; and the third, the dome connected to the jacket and bottom by flanges, bolts, and nuts. Below the flange, within the bottom, is a worm or spiral of pipes common to the curved shape of the bottom. The lower end of the worm is connected, to discharge into the space between the bottom and jacket, the upper end being secured to the dome, outside of which is the steam supply stop valve. On the top of the dome is secured the discharge air and steam pipe, termed technically the "arm pipe," extending to a vessel beyond the flange known as the "receiver." Formed with this last is the condenser, into which the steam is finally discharged. The system of condensation is the injection or surface kinds. In my own practice I prefer the injection to any other, owing to the surcharged state of the steam: its simplicity is also a great recommendation. Surface condensers are not objectionable, considering that the injection is equally as efficient, to say nothing of the first cost—a matter of consideration ever in the mind of the planter. I have seen a better vacuum produced, with less air pump power, by locating the condenser at the top of the building, and allowing the fall of the water to assist. To return to the description of the remainder.

At the side of the arm pipe is the man-hole; in some cases it is on the top of the same, but the former position is preferable for entering and leaving the pan. At the side of the flanged connection, opposite the condenser, is located the "measure." This vessel receives the syrup before it enters the pan, a gauge indicating the quantity. To enable the sugar-boiler to see into the pan when in operation, light glasses are placed on opposite sides of the dome. It may now be wondered how the state of the sugar within the pan can be known without stopping the boiling and exhausting. This is attained by an ingenious arrangement, termed a "proof stick." From its name, the casual observer would imagine that this is actually of wood, and simple in shape and construction. On the contrary, it is complicated, and of the best metal, fitted bright throughout. The stick or rod is a copper tube, from the handle to the lower end, where a drilled cavity is formed for about two to three inches in length. The rod is then closed by plugging and brazing. Near the extremity a narrow opening is cut in the side of the rod, thus forming an external communication with the cavity alluded to. I may here state that the rod is inserted in a case or tube connected to the dome and the worm. This casing contains a hollow plug at the inner extremity, for a given length, into which the rod or stick fits. Corresponding openings are formed in the plug and casing. It is obvious then that on turning the rod and plug to agree with the opening in the outer casing, the sugar will flow into the cavity in the rod; and on closing the outer opening, the rod can be withdrawn without affecting the vacuum. The remaining appendages for the vacuum space consist of liquor, air, steam, safety and vacuum valves, barometer and thermometer, sugar discharge valve, condensed steam valve, gauges and valves to the measure, receiver, and condenser. It will thus be seen that the vacuum pan is rather a formidable opponent to the open boiling system, inasmuch as that if the requisitions alluded to are imperative, the neglect of the same must be no common error. To enable the practicability of each detail to be duly understood, I will describe the process of using the vacuum pan for granulating sugar. Presuming a vacuum to be caused in the pan, the valve of the pipe connecting from the tank is opened; also the vacuum valve from the measure to the pan. The liquid sugar rushes into the measure until the gauge indicates the required quantity. The supply is cut off, and the communication from the measure to the pan opened, when the former is soon emptied. Steam is now circulating through the worm and the space between the bottom and jacket, thus heating the syrup. Fresh charges from the measure are added till the pan is sufficiently filled, which, when attained, is termed a "skipping." The amount of sugar that can be granulated in a given trial depends much on the nature of the sugar and the size of the pan. A pan 8 feet 6 inches in diameter, and 10 feet deep, will boil at the rate of about two tons per hour, or three and a half skippings in one day—total, 28 to 30 tons. Presuming the sugar to be

boiling, the process of taking proof is resorted to at suitable intervals. The operator inserts the rod into the pan, with the opening towards him. On turning the rod to the right, the sugar in the pan is received into the rod as much as available; on reversing the action of the handle the rod can be withdrawn. The sugar boiler now holds the lower extremity towards his disengaged hand, before a gas light. The sugar in the cavity is allowed to fall between the forefinger and thumb. On turning them at right angles, and extending the same before the light, the grain of the sugar can be detected during its formation and completion. A basket or small barrel of water is located near the proof-rod casing, in which the rod is put between the intervals of taking proof, also for the purpose of washing the fingers. It may be added, in passing, that a small pan or dish receives the proved sugar from the fingers of the operator. Now, presuming the sugar to be sufficiently crystallized, the discharge valve is opened, also the air or break vacuum valve, and the sugar is let into the vessel for its reception. I may here state that if the sugar is improperly boiled it assumes a semi-liquid state, termed "smear," and in other cases it will "set," or "boil fast," and become so hard in the pan, that the use of pick-axes and shovels is required to remove it, to say nothing of the damage incurred and uselessness of the material afterwards.

Engine and Air-Pumps.—The kind of engine mostly used for working the pumps is the high-pressure beam type. Each pump is single-acting, located on each side of the central support of the beam gudgeon; I prefer using a horizontal pump and engine, the former double-acting: by this arrangement I can produce a certain effect at much less cost than the primitive mode.

6. Charcoal Filters.—These are cisterns of cylindrical form, slightly conical, the lesser diameter being at the base line. A false perforated bottom is secured 12 to 15 inches from the solid termination, above which is the man-hole for clearing the charcoal when requisite. On the top of the filter is a float and stop-cock, to prevent the overflow of the syrup. The charcoal is prevented from being washed through the false bottom, or choking the same, by a piece of flannel placed between the bottom and the charcoal. I have designed these filters with a casing, and, by introducing steam at a low temperature, the requisite heat is preserved to prevent coagulation. The sizes of the filters vary; in some cases 4 to 5 feet in diameter and 10 to 15 feet in height, in some cases 22 feet.

7. Centrifugal Machines.—It will be remembered that in a previous portion of my paper I explained the principle and use of these machines; I now proceed to describe their form and constitution. The shell is cylindrical, open at the top; and the bottom located one-third of the total height from the base-line; the bottom forms a spiral in elevation, to enable the syrup to more readily flow out at the opening at the side. The basket is hung on a cone, which latter is supported on a perpendicular shaft. This shaft revolves on bearings, formed in a separate casting, extending above and below the bottom of the shell to which it is connected. The basket is made solid at the bottom, the sides being a combination formed of wire and gauze-work. The size is about 2 feet 9 inches to 3 feet 6 inches; in some instances larger, the most universal being the former. Their use is as follows: The melted sugar is put in the basket, to the amount of 3 cwt. at once. A speed of 600 to 1,000 revolutions per minute is imparted to the machine, when on stopping the sugar will be found to be in a dry state, adhering to the sides of the basket, and weighing about $2\frac{1}{4}$ cwt., the remainder being the syrup. I may add that a steam jet is sometimes used to preserve the temperature of the sugar during the operation of drying or draining. Now with reference to the means for imparting the motion to the machine in question: The primitive mode has been by gearing, belting, pullies, and the paraphernalia requisite. This has been surpassed by small engines of the requisite power, either being connected direct or making good the motion by belting. In some instances horizontal engines are adopted; other authorities prefer perpendicular power and bevel gearing; while a third has advocated the flow of water through hollow avenues, being a compilation from the idea that Hero of Alexandria had for producing rotary motion. I may here state a patent has been granted for this latter mode of causing centrifugal motion. In my practice I prefer a horizontal engine, with a belt and a small pully, the larger acting also as a fly-wheel on the crank shaft, the slackness due to the expansion of the belt being adjusted by suitable provisions.

8. Tanks, &c.—In this clause I have many details to allude to, commencing with "tanks." These are of simple form and construction, either of wrought or cast-iron, fitted or not, as may be required, with heating coils, &c. The "moulds" are conical in shape, and further conical at the smaller extremity to a point. They are made of sheet-iron galvanised, in other cases of cast-iron similarly treated, and in some instances of copper, but the latter rarely. The "scum press" is merely a simple screw press of ordinary design and utility. I may here state that hydraulic pressure is being introduced for this purpose with great effect. "Coolers and heaters."—The former is a semi-elliptical vessel, the latter the same form surrounded by a casing. The space between, being filled with steam, heats the sugar at the bottom. "Condensing box."—The title of this detail readily conveys its use, therefore a simple allusion is only necessary. The body or shell is cylindrical, within which is a float of copper, attached to a valve located in the bottom of the casing. The steam (to be condensed) enters at the top of the vessel and the injection water opposite. The vapour and the fluid amalgamating cause the float to rise, and thus the requisite discharge ensues. "Expansion valve."—The utility of this valve is to admit the steam at one portion at a given pressure and at another discharge the steam reduced to the requisite temperature simply by expansion. Arrangements innumerable have been introduced to attain this desideratum. Patents have been granted to protect the same, each device of course claiming the recognition of the law. Mercurial valves have been introduced; slide, cylindrical, and disc valves have had trial, but fail more or less, owing to one cause, viz., friction of the working parts. In 1863 I invented an expansion valve, which greatly eradicated the evils alluded to, but being founded on the faults of its predecessors, I cannot lay claim to much originality. Suffice it to say, the valve in question dispenses with stuffing boxes, levers, and slides, each of which is conducive to friction; they are therefore great barriers to the correct indication of an expansion valve.

9. Charcoal Furnaces.—When allusion was made to the liquid sugar being filtered through the charcoal, it was obvious that the impurities were left behind. It is now my purpose to describe the removal of the refuse of the sugar in the charcoal. Before doing so, however, I will give a brief description of the chemical properties of the bone. In so doing I must quote from an article entitled "A Visit to a Bone-Boiling Factory," by myself, inserted in the *Technologist*, October, 1863:—

"The decomposition of bone by heat in close vessels, whereby the action of atmospheric air is excluded, is well worthy of minute attention, both in consequence of the large scale on which it is carried on as a chemical manufacture, of the importance of the products obtained, and the interest which it possesses in a scientific point of view.

"The animal matter of bone is the only constituent part of this substance capable of decomposition by a heat brought up to low redness; in considering, therefore, the action of close heat on bone, the earthy ingredients may be considered as passive. The animal matter is either a substance analogous to skin, or is a mixture of membrane and jelly; the former opinion is supported by some of the

most eminent modern chemists, but it is of no sort of importance to our present purpose which opinion is adopted, as all three substances are composed of the same ultimate elements, and nearly in the same proportion. The four simple substances, then, of which the animal matter of bone is composed, are carbon, hydrogen, nitrogen, and oxygen; and of these the three latter, when in an uncombined state, and at the usual temperature and atmospheric pressure, are in the form of gas. Now when it happens that these substances, habitually gaseous, are combined with one naturally solid, and when these four substances are likewise capable of uniting together by twos or threes, or, in other words, of forming binary and ternary compounds, the attraction that holds together all the four is easily disturbed by a moderate increase of temperature; in consequence of which the same elements, by arranging themselves differently, produce two or more different substances.

"This is the case in the present instance. On exposing bone shavings even to a lamp heat, they are observed immediately to become black, showing that the new compounds that are the result of this decomposition are not capable of combining with the whole of the carbon, but that part remains in a state of charcoal intimately mixed with the earthy matter. The mixture goes by the name of bone black or animal charcoal.

"Part of the carbon combines with part of the oxygen, and forms carbonic acid, while part of the hydrogen and part of the nitrogen produce ammonia; the carbonic acid and the ammonia, as they are formed, combine and produce carbonate of ammonia, which, therefore, is another of the useful substances resulting from the decomposition of bone. Part of the oxygen and hydrogen combine and produce water; and part of the oxygen, the hydrogen, and carbon, by combining, produce an oil of a strong and peculiar odour, which goes by the name of animal oil. The remainder of the carbon and hydrogen, with probably some nitrogen combine, and produce an inflammable gas. Thus the decomposition in close vessels, of the single substance, bone, produces five new substances, namely; animal charcoal, carbonate of ammonia, animal oil, water, and an inflammable gas."

Now the mode of revivification is by reburning in closed vessels, allowing the gas to escape into suitable air-tight receptacles by exhaustion. The arrangement of the retorts for the colonies is often with elliptical pipes, vertically secured in brickwork. The charcoal is put in each retort, which, when full, is hermetically sealed, and the gas is condensed, or rather consumed within the retort, with the exception of that which escapes through the bottom. A test pipe indicates when the charcoal is sufficiently burnt, and on withdrawing the bottom slide the charcoal can be readily emptied into cisterns. The mode is, perhaps, the most simple that can be conceived, and is much used in the present day. Within the last few years great improvements have been made; the aid of the engineer has been resorted to. As far back as 1846 revolving retorts were introduced, and since that period have gradually been extended in adoption. The first mode was to hang the retort on chains, suspended on revolving pullies; motion being imparted to the latter, caused the cylinder to revolve within a furnace. The retort was charged at the front end, and the gas escaped at the other into water, being conveyed thereto by a pipe. The great fault with this arrangement is the crudeness of the machinery, and exposure of the charcoal to the atmosphere when discharging. Messrs. L. Cowan and Sons have a very good arrangement of single retorts. Mr. George Torr, of charcoal repute, has an arrangement of double retorts, or one above another. The upper retort receives the charcoal, partially cleanses it, and the lower retort completes the process. The inside of each retort has cast with the body a spiral throughout, and thus the charcoal is self-traversing, both feeding and discharging. Mr. J. F. Brinjes, an engineer, who has devoted much attention to the machinery requisite for the purposes alluded to, adopts two retorts, similarly arranged to Mr. Torr's, but in this case a mangle motion is deemed by Mr. Brinjes to be preferable, suitable provisions being formed internally. Space and time will not admit my entering further into this matter in detail, but I must conclude by stating that the amount of charcoal revivified by Mr. Brinjes' arrangement in one week is 90 tons, requiring 10 tons of fuel. This may be said to be a great advance, showing that science was sadly neglected, when, with twenty fixed retorts, only one ton of charcoal was revivified in twenty-four hours, consuming one ton of coals to five of charcoal.

10. Casks.—The details in this clause are of such an obvious character, that I may briefly state that the crafts of the carpenter and cooper are only requisite, and therefore they need no further comment here.

Home Machinery.

The machinery I have just alluded to completes the process of refining in the colonies; therefore, with the exception of the cane mill and clarifiers, duplicates are required for home manufacture. The first requisition in the present case is the blow-up pan, being cylindrical or rectangular in plan, fitted with a perforated false bottom, underneath which is a worm. A vertical shaft, having arms, agitates the melting sugar, and thus greatly accelerates the process. I may here add, that an ordinary pan will blow up, or melt, four tons of sugar in one hour. The origin of the term "blow up" was taken from the fact, that the sugar used to be exposed to jets of steam blowing up through the perforated bottom. Such a practice produces molasses. I will now allude to the arrangement of the machinery.

For colonial practice much depends on the locality, the class of sugar to be produced, and divers other considerations. The main portion to be noticed is the accessibility to all the working parts, also the removal of any part without disarranging the neighbouring portion. As most of the process is carried out on the ground floor, platforms and stages are imperative. Glass windows should never be introduced, due to the heat and scarcity of the material for repairs. The rule for arranging the machinery for home practice is generally the least area with unlimited height, or the reverse of that for the colonies. Having thus far investigated the subject I have had the honour of bringing under notice, I will next allude to the prices, both of the machinery and sugar. According to reliable authorities, the component portions of the sugar cane consist of

Woody fibre, &c.	10
Water.........................	72
Sugar	18
	100

Now the sugar mill does not extract the entire liquid; indeed some assert that out of 90 per cent. of juice known to exist in the cane only 60 are extracted. With the improved machinery now in existence 70 to 75 per cent. can be ensured, remembering that the speed of the roll should be in just proportion to the nature of the cane; in fact, when this has been observed, 85 per cent. of juice has been extracted. In round numbers 1,800 to 2,500 gallons of cane juice will make one hogshead of raw sugar, weighing sixteen to eighteen cwts., and in some instances a higher standard has been produced.

To enable a fair price to be given for sugar machinery, many contingent expenses must be added to the actual requirements. I give the following estimate for a perfect colonial sugar factory, producing ten to twelve tons of refined sugar per diem, exclusive of the building and erecting:—

Three boilers and fittings	£1,200
One high-pressure engine	580
One cane-mill and gearing............	2,100
Three steam clarifiers................	1,200
Three bag filters	489

Six charcoal cisterns	360
Two vacuum-pans	2,000
Two air-pumps and engines	700
Two heating-tanks	280
Three plain tanks	200
Two heaters or coolers	220
Six centrifugal machines and engines	960
Steam piping, troughs, expansion-valves, condensing-boxes, scum-press	1,800
Four revolving retorts	560
	£12,649

A refinery at home to produce twenty tons of refined sugar per diem will cost about £8,000—fitted complete.

PRICES OF COLONIAL AND FOREIGN SUGAR.

West India.

Name of Colony.	Kind of Sugar.	Price per cwt., duty paid.
		s. d. s. d.
Jamaica	..	30 6 to 36 0
"	Fine	36 6 " 37 6
Barbados	..	30 0 " 39 0
Trinidad & Antigua	..	29 6 " 33 0
"	Fine	34 0 " 36 0
Demerara & Berbice	..	29 6 " 35 0
"	Crystallized	35 6 " 40 6
St. Kitt's and St. Vincent	..	29 6 " 35 6
Dominica & St. Lucia	..	29 0 " 33 0
Surinam	..	29 6 " 34 0
Havana	Brown	32 0 " 34 0
	Yellow	34 6 " 38 6
	Florettes	39 0 " 41 0
Porto Rico & Cuba Muscovado	Fine	36 0 " 40 6
	Yellow	34 0 " 36 0
	Brown	29 6 " 33 6

East India.

Name of Colony.	Kind of Sugar.	Price per cwt., duty paid.
		s. d. s. d.
Bengal	Factory mid. to fine yellow	34 0 to 41 0
	Benares, yellow and white	33 0 " 39 0
	Date, yellow	30 6 " 35 0
	" brown	24 0 " 29 0
	Khaur	24 6 " 26 0
Madras	Factory, yellow and white	33 0 " 41 6
	Brown and soft, yellow	25 0 " 29 6
	Jaggery	24 0 " 26 6
Mauritius	Crystallized	33 6 " 40 0
	Yellow and grey	30 6 " 34 6
	Brown	25 0 " 30 0
Penang	Grey and white	34 0 " 38 6
	Yellow	31 0 " 34 0
	Brown	26 6 " 30 0
Siam and China	Yellow and white	31 6 " 40 0
	Brown	25 6 " 30 0
Manilla	Currant clayed	29 6 " 30 6
	Muscovado	25 6 " 27 0
Java	Grey and white	35 6 " 40 0
	Yellow	31 6 " 35 6
	Brown	27 0 " 30 6

Before concluding my paper, I may state that, although rapid improvement has been made, much yet remains to be accomplished. This fact presents itself more vividly when I see the small amount of refined sugar produced in proportion to the quantity of cane cut. This also clearly shows that there must be a fault in the manufacture, as well as in the machinery. I would suggest to the planter, and more particularly to the refiner at home, that they injure their own interests by making such a mystery of their art, which, I am aware, is one of the most worthy of development. I am also confident that much is due to the arrangement of the plant; and that but little progress would have been made in sugar machinery had it not have received the attention of the English engineer.

DISCUSSION.

Mr. P. L. Simmonds said that it must be admitted by all present that the subject discussed that evening in its several relations was one of great importance, not only to this country but the world at large. Enormous as the production of sugar already was, yet with the increase of population and the progress of colonisation it would still advance. It was an article of consumption for which there was always a steady, and, with low duties, an increasing demand. It was not only in our own tropical colonies that cane sugar was largely produced, but in almost all tropical and sub-tropical countries more or less was made, in some cases in a very rude and primitive manner, in others by more scientific processes and improved machinery. The British and foreign West India colonies were long the main sources of supply for Europe, and his experience as a sugar planter, extending back some thirty years, brought to mind the rude crushing mills, worked by cattle power, and the very raw muscovado, with a great quantity of "foots," and large drainage of molasses, in potting and curing, resulting from sugar made chiefly under negro management in open boilers. How great was now the change in manufacture was shown by the beautiful specimens of crystallized sugar produced in Demerara, the French West India colonies, Réunion, and especially Mauritius, which were before them on the table. Glancing at the sugar production on the American continent, it might be stated that in the Southern States of America there was formerly a large production of cane sugar, which was not likely to be maintained from the want of labour. The Americans were now turning their attention largely to the production of sugar from the sap of a species of Sorghum cane; but although this might answer on a small scale for domestic use, like the maple sugar, it was never likely to come into extensive competition with cane sugar. More southerly on the American continent, a good deal of sugar was made;—in Mexico, the Central American States, Peru and Brazil. In the Sandwich Islands there was a very creditable production, which was chiefly shipped to California. The French were also pushing sugar cultivation in some of their colonies, Tahiti, the Marquesas, and New Guinea. In parts of Africa some attention was given to sugar cultivation, especially in Egypt, Liberia, and in Natal, from which there were some creditable specimens on the table. But it was towards the East that sugar production was now largely converging,—from the great advantages of abundant and continuous cheap labour. Some of the purest sugars in the world were now produced in the Islands of Bourbon, or Réunion, and Mauritius. The latter was the first colony to avail itself of all the improved and most expensive sugar machinery, both from England, Scotland, and France, and there was no colony in which sugar manufacture was carried on in so scientific a manner. Proceeding eastward, Madras and Bengal were considerable producers of sugar, as were the Spanish and Dutch colonies in the Eastern Archipelago. In Siam, China, and Japan the manufacture of sugar was much larger than was generally supposed. Some of the recent commercial reports from our consuls in China gave interesting details of the sugar production and trade of China. It might naturally be asked why, when such very superior white sugar could be made, and was largely made, in our colonies—so large

a proportion (four-fifths) of that imported should be of the lower quality of brown Muscovado, or below brown-clayed. One reason was, that there was a difference of about 3s. per cwt. in the rates of duty, and this shut out much of the better prepared sugars from our market, causing all the superior Mauritius to be sent to Australia, and our British refiners did a large amount of profitable business in converting the crude raw sugar into the loaf sugar which was before the meeting. There was no reason why the whole refining processes might not ultimately be carried on in several of the colonies with great advantage and economy of material and freight. There were sugar refineries now in operation in Melbourne and Sydney, and specimens of this produce were before them. Although it was scarcely to be expected that the Chancellor of the Exchequer would be prepared to yield any further concession in the sugar duties for some time to come, every reduction stimulated consumption; thus he now received as much revenue, at less than one-half the former rate of duty, as was obtained in 1844, when the average rate of duty stood as high as 25s. 2d., against 11s. 1d. now. This resulted from the imports having doubled, and there could be no doubt that if a better class of refined sugar could be cheaply obtained, it would be as generally used as the protected refined sugar was now on the continent, instead of raw colonial sugars. Every improvement that could therefore be made in sugar machinery, and every publicity that could be given to improvements, were most important, and the thanks of the Society were due to Mr. Burgh for bringing this matter so ably before them.

Mr. Henry Maudslay remarked that he had a very early remembrance of the ponderous machinery which was formerly used to extract the juice from the sugar-cane, but it was now much improved, its construction forming a special class of engineering in this country. In different countries, different methods of preparing the sugar were adopted, and he felt that he could add nothing to what had been so fully stated in the paper descriptive of those processes. It had been very truly remarked, that before the Exhibition of 1851, where for the first time the public had an opportunity of seeing specimens of sugar machinery, very little was generally known about the nature of that machinery, although the whole subject was one of great interest and importance, as affecting an article of such universal use; for owing perhaps to the jealousies and competition of the trade, sugar refiners in this country considered it undesirable to allow the public to inspect their works. Since that period he believed the subject had been more generally attended to by engineers in this country; immense improvements had been made in the generation of steam, in the machinery for crushing the cane, in the use of the centrifugal machines for defecation, and in arrangements for the other processes employed in the preparation of sugar. He might mention that the machinery employed in New York was the most beautiful that could be imagined for producing the crystallized fruits with which all were familiar, and for the production of which special arrangements were required. As far as his own knowledge of the mechanical portion of the paper went, he would say it appeared to him that the descriptions given were so complete that very little remained to be added.

Mr. John C. Wilson, without desiring to detract at all from the merits of the paper, begged, as one who had had some experience in this class of machinery, to point out what he considered were defects in the plans submitted by Mr. Burgh. He would commence with that of the sugar mill, which Mr. Burgh called "improved;" but for his own part he was unable to see wherein the alleged improvement consisted. The great objection to the old description of sugar mill was that the different parts of the machinery were disconnected from each other, and were attached to separate foundations, and this was not obviated in Mr. Burgh's plan. There was necessarily a very severe strain through all the parts of a sugar mill, and when the foundations were separate the brick-work was liable to give way, and the machinery was then put out of truth and breakages resulted. His own idea of an improved mill was that all the parts of it should be combined on one substantial iron foundation bed, so that the great strain was taken through the solid mass of iron. He observed that the side-bearings of Mr. Burgh's mill were, what he considered, of an antiquated description, weak in construction, and liable to break down, and it appeared that the lower rollers were not easily removable for cleaning the mill. Another point in this machine was the coupling between the gearing and the sugar mill, which he thought should be dispensed with. It was an inconvenient and dangerous thing, and there was not the slightest use in it. If the lowest wheel was fastened on direct to the top roller shaft, it answered all the purpose, and saved complication and expense. The boilers advocated by Mr. Burgh were of the Cornish description, but he (Mr. Wilson) had found them to be not well suited for burning the bulky fuel megass which was used in the colonies, for to do that properly a very high fire-place was required, so as to give considerable space between the fire-grate and the bottom of the boiler. He observed that the chimney was of wrought-iron, which he considered to be a great defect. In the earlier stages of his experience he sent out a wrought-iron chimney, and the report of his agent was that it melted away and totally disappeared. He also observed that in Mr. Burgh's plan there appeared to be no means provided for lifting out, for cleansing purposes, the steam pipes by which the clarifiers were heated. In the process of clarification there was a great amount of sediment deposited, and unless there were means of lifting out the steam-pipes at the end of each clarifying operation, this could not be removed. It was stated that the milk of lime was used to prevent the fermentation of the liquid sugar; but he thought this was a mistake. It was rather used to coagulate the albumen of the juice, which, when thus coagulated, fell to the bottom of the clarifier. It was stated that the vacuum-pan was adopted as a means of boiling the juice in less time; but the great advantage was that it boiled at a lower temperature than the open pans. Mr. Burgh had spoken of the reluctance of engineers to give information on this subject. This, however, was not surprising; the practical information which engineers required with regard to this machinery was often obtained from abroad, through the medium of agents sent out at considerable expense, and it was not to be expected that they should offer that information gratuitously to everybody. They were quite ready to give information, provided it did not involve the giving away of that which they ought not to give away in justice to themselves and their business.

Mr. Botley mentioned that some years ago, wishing to give a lecture on the manufacture of sugar before a Mechanics' Institution in which he was interested, he personally experienced the reticence spoken of on the part of the refiners, and found that they were very reluctant to allow persons to inspect their works. The greatest improvement which had been effected in the refining of sugar, he believed was that which was patented by the son of the Duke of Norfolk in the last century; that was the vacuum pan. He believed that discovery led to the first production of refined sugar in the form of the loaf. It appeared to him, from the little insight he had gained into the subject, that there was still room for improvement in the machinery employed in this important manufacture; and he agreed with the author of the paper, that if the refiners were less chary of admitting people to see their works, they might gain some new suggestions which would be advantageous to them.

Mr. Ogilvy thought that, looking to its practical importance, the invention of Mr. Fryer alluded to in the paper was deserving of a more extended notice than had been given to it. The article produced was a species of

grey lump, called "concrete." In the manufacture of sugar the object was to produce the saccharine portion of the juice in a crystallized form, and for this purpose the separation of the water was effected by heat; but if the heat was carried to too high a point it either destroyed a portion of the sugar, or converted it into molasses or treacle. Mr. Fryer found that if he could keep the temperature below 140° Fahr. little or no molasses would be produced, and his object then was to evaporate the water without exposing it to a high temperature. It was well known that if a quantity of water were put into a saucer, and exposed to the sun, it would be a long time before the water would evaporate, but if the same quantity of water were thrown upon the stones of a yard it very soon dried up. Mr. Fryer had applied this principle to his process in this manner:—The juice as it came from the expressing machine was received upon a large iron plate—say 30 feet by 6—in which there were a number of divisions, forming a long continuous channel, so that the juice might flow from one end of the plate to the other. Under this plate the furnace was placed, and the temperature was kept low. The extent of surface over which the juice passed caused the water quickly to evaporate; and by the time it arrived at the end of this iron plate, as much as eleven-sixteenths of the water was got rid of. The sugar was then placed in a cylindrical vessel, in which it was kept in continual agitation, exposing a large surface to a blast of hot air passing through the cylinder, by which means the whole of the remaining moisture was speedily carried of; the syrup was then finally passed over a drum, where it was again exposed to heat, and the process was complete. A scraper was placed in front of this drum, to scrape off the sugar. By these means a beautiful article, of a grey colour, was obtained, entirely free from water, and containing very little molasses. He regarded this process as a great revolution in sugar manufacture, and it had been highly approved by those West India planters who had seen it.

Mr. Gadesden said, though he was one of those exclusive individuals of whom it was remarked that they wished to keep prying eyes out of their establishments, he would venture to go a little further in explanation of Mr. Fryer's new process than the last speaker had gone, probably from not being acquainted with the latest modifications of that process. In the first place, it was stated that the fire under the flat plate over which the liquor passed in a thin stream was not very powerful. The fact was, the heat might be as powerful as the energies of coal and air could produce; they might have white heat under it without doing damage to the juice, either in colour or in composition. Moreover, the exact amount of crystallized sugar which existed in the cane would be found to exist in the solid "concrete" produced at the end of the process. As far as Mr. Fryer's experiments had gone at present, he had used the syrup at a density of 16° Baumé. Even a mixture consisting of less than one part of water to one of sugar might be subject to a high temperature without any injury to it whatever, provided there was sufficient evaporating surface. When the syrup had been reduced to that density, the remaining water was drawn off by passing a current of air at a temperature of 800° over it in a rotatory cylinder provided with apparatus for dividing the liquid into fine streams. He might add that Mr. Fryer had found under these circumstances that the drum spoken of by Mr. Ogilvy as forming the last process was not necessary, the drying in the cylinder being found sufficient to cause the sugar to coagulate into a hard mass the moment it was cooled, when it was fit for shipping, the whole process being effected in one day, from the cutting of the cane to the shipping of the article. That was an enormous advantage, which those unconnected with the business could hardly appreciate. In the first place the quality of the sugar was not deteriorated, and, in the next place, all the sugar that the cane contained was delivered into the vessel, and there was no loss from drainage on the passage. By the ordinary process of manufacture not more than 66 per cent. of the sugar found its way to the consumer; the remaining portion being lost by conversion and degradation from sugar to molasses, as well as by drainage during the passage. The process of Mr. Fryer must be regarded as of great value, and he could speak much for the results he had mentioned, from personal experience of its efficiency.

The Chairman said it would be presumptuous on his part to detain the meeting with any observations on a subject with which he had no practical acquaintance as a planter or manufacturer, but thirty years' of official connection with our sugar producing colonies in the West Indies had given him an abiding interest in their prosperity, and he rejoiced at any opportunity which presented itself of manifesting that interest. The well-being of those portions of our possessions was intimately connected with sugar production, and he felt much indebted to a gentleman like Mr. Burgh, who took the trouble to bring before the public matters in which the interests of our colonies were so deeply involved. It was obvious, from what they had heard this evening, that improvements in machinery for the manufacture of sugar were possible. He had no doubt that even at the present day in some parts of the colonies they would find the old wooden mill in use, driven by mules, expressing the juice from the cane, as far as such imperfect appliances could do so, the juice being put into skin bags, and carried by the mules to the shipping ports. There could be no doubt that the British planter was overweighted in the race of competition. The object was to produce this commodity as cheaply as possible; but we must bear in mind that every improvement in machinery was available to competitors, who had the advantage over British planters in the matter of labour, and he believed the true remedy of the difficulty would be found in those halcyon days which he hoped were looming in the future—when the Chancellor of the Exchequer would find himself in a position to be able to dispense with the sugar-duties. That, together with the total abolition of slave labour, which he hoped was not far distant, would place the British producer on a footing of equality with his foreign competitor. Having no private interest to serve, he might be permitted to say that a class of men more intelligent, more energetic, more liberal and willing to adopt every possible improvement, either in the cultivation of the cane or the manufacture of sugar, could not be found anywhere than the planters in the British sugar-producing colonies. He had now to ask the meeting to accord their cordial thanks to Mr. Burgh for the very interesting and able paper with which he had favoured them.

The proposition having been unanimously agreed to,

Mr. Burgh, in acknowledging the compliment paid him, said it appeared to him that if the Government were to lower the sugar duties there was no doubt that the producers abroad would send refined sugar to England. As regarded beet-root sugar he did not think at present its manufacture had been fairly carried out, because he found, from experience, it was not only bad in smell, but bad in taste also. In reply to the criticisms which had been passed by Mr. Wilson upon the machinery described, it seemed to him that that gentleman had not examined the drawings accurately; for the arrangement of the mill and gearing which he (Mr. Burgh) recommended was, in fact, more simple and effective than any other. He did not say it was entirely his own, for he had seen others similar to it, but he had made some improvements, and consequently was warranted in calling it "improved." Then, again, Mr. Wilson disapproved of the disconnection of the machinery, but he (Mr. Burgh) had been requested by planters to provide disconnecting gear, because, in case of accident, they liked to be able to disengage immediately.

With reference to another objection made by Mr. Wilson, that the lower rollers were not readily removable, he could only say that with his arrangement this had been effectually provided for. As to the wrought-iron chimney, it was now coming into general use in the colonies, and there must have been some mistake in the instance referred to by Mr. Wilson in the setting of the boilers and in the proportions of the flues. Then as to the clarifiers, it was objected that the worms could not be lifted out; but here Mr. Wilson was in error; this had, in fact, been provided for. As to the vacuum-pan, he maintained it would boil the liquor in less time, as well as at a lower temperature, and would produce better sugar than the open pan.

The paper was illustrated by numerous specimens of the raw and refined sugars of commerce, lent by Mr. Burgh; also by specimens illustrating the whole process of refining, lent by Mr. Burgh and by Messrs. L. Cowan and Sons, of Hammersmith Bridge Works; also by very fine samples of the superior sugars of Mauritius, kindly lent by Mr. James Morris; also by samples of the various prize sugars shown at the Exhibition of 1862 and at the Dublin Exhibition of 1865, with many curious illustrations of the maple, beet-root, and date sugars, potato sugar, glucose or grape sugar, gluten or starch sugar, Chinese and Australian sugars, from the collection of Mr. P. L. Simmonds.

METHODS OF MUSICAL TEACHING.

The following is from the *Athenæum*:—

7, Hamilton-terrace, March 20, 1866.

I hope you will allow me a few lines' space for illustration of the views I stated in my former letter,—namely, that in a national Musical Academy every Professor should teach according to his own method and his own conviction, and none be bound to a fixed text-book that was authorized and enforced by the rules of the institution,—since these views seem, from Mr. Chorley's remarks upon them in the *Athenæum* of March 17, to have been misunderstood, at least by that gentleman. He states, in support of a contrary principle, that the Fugue made no advance from the time of Bach to that of Beethoven. Certainly it did not; but the Symphony made the prodigious progress from its germinal state in the orchestral *suites* of the former composer to its perfection in the masterpieces of the latter. It may be supposed from Mr. Chorley's argument, however, that had the contemplated Academy been established in the time of Bach, and the authorized text-book for the study of composition been then as far as possible perfected in its exposition of the several forms of construction then in use, it would not be unlawful for a Professor of this branch to teach the grand system of musical development exemplified in the Symphony, and to cite the great works of Haydn, Mozart, Beethoven, and Mendelssohn in proof of its capability, its comprehensiveness, and its endless versatility. On the same principle, a text-book, compiled before the time of Bach, would ignore the system of equal temperament; and, albeit the propriety of its adoption has recently been disputed by one of our most esteemed organists, there can be no question that the whole of modern music, including the forty-eight Preludes and Fugues which Bach wrote to illustrate the system, would be utterly impracticable did any other plan of tuning than that of equal temperament now prevail. Again, had a permanent text-book for clavier-playing—whether on the harpischord or pianoforte is indifferent, as regards the laws of fingering—been legalized prior to the innovation of Bach and Couperin, a teacher would now not be allowed to direct his pupils to employ the thumb when playing on the pianoforte, but would surely be at his wit's end to show him how to execute passages without the aid of this essential member. Had the Median and Persian text-book for the violin been enacted when Corelli lived, it would now be forbidden to teach pupils to play higher than D in the whole shift or third position on the string; an anecdote being current that this famous executant refused to play a passage of Handel's which included E on the third leger-line, affirming that this note was not in the orthodox scale of the instrument. Nay, had the text-book for the violin been dated a century later, it would now be treason to such a statute were any professor, to expound the method of fingering, to produce harmonics with an artificial nut, invented by Paganini. Had the rules of flute-playing been paralysed before Boehm effected his admirable reconstruction of the flute, we should now be restricted to the fingering, if not the blowing also, available only for the old instruments, and it would be all but impossible to procure instruments upon which to practise. Had the laws of harmony been petrified two hundred years ago, it would be now a breach of discipline to explain the use of the unprepared dominant 7th, and of the second inversion of a common chord, not to say all the beautiful resources of modern chromatic harmony and melody, with which the discoveries of true genius have from time to time enriched the art. At the date of the foundation of the Royal Academy of Music, no text-book would have provided for the inculcation of the Gregorian modes, which were at that period as entirely out of thought as out of use among musicians, but a knowledge of which has now become indispensable, not only to familiarize us with an important though exceptional branch of music, but to enable us to contend against the clerical influence which strives to enforce this revived remnant of paganism upon general adoption. It is as needless as it would be easy further to multiply facts to prove that text-books, organised for a national academy at any of the periods to which allusion has been made, would be insufficient for the necessary, not to say complete, instruction of musicians in the present day. I will only add to the above, that, since the age of study in an artist's life never ceases, since his whole career may be hoped to be a course of improvement, it would indeed be wantonly arbitrary to insist that, in the utmost maturity of his acquirements, he should teach all and no more than he knew at the dawn of his experience in tuition. Who shall say that the stream of musical progress, whether in executancy, or production, is arrested? Who shall say that the well of musical truth, whence most wonderful facts in the law of combination still continue to be drawn, is exhausted? If, as I trust, no one can be so daring, nay, so mad, as to assert these paradoxes, how can it be reasonable at any given moment, now or hereafter, to enact a code of rules for a course of musical instruction that shall define what is to be taught, and limit the explanations of professors in all time to come? I have sought your indulgence thus far in no captious spirit of opposition to Mr. Chorley, but in the wish so to illustrate my previously-stated views, that they may be fairly judged in comparison with any that may be urged against them. G. A. Macfarren.

Mr. Chorley replies as follows:—

March 26, 1866

It would suit me as little as I suspect it would suit the *Athenæum* to protract a controversy after each party had stated his own views. That Mr. Macfarren has utterly mistaken mine is evident by his meandering back to days when certain branches of the art of music were manifestly incomplete, and by his sarcastically suggesting an imagined academical finality which would then have been preposterous, in order to show the absurdity of my recommendation of some fixed convictions and recognised models. He waves aside the demonstrable fact, that in all the creative arts wherein science has part, there have been great periods, regarding which there can be no dispute; and he, mistrusting the past as an object of study, and its precepts as having authority, would give up masters and scholars (invited to discuss their masters' methods of teaching) to the chances of discovery. So be it, and let all who have acquainted themselves with the history of music and the history of art judge between us, and decide how far I am pedantic and narrow-minded in recommending

unity of counsel and fixity of purpose and opinion as a first necessity to a collegiate body of professors, who are to form the talent of their pupils. Genius, I once more repeat, has no need of academies, but makes rules for itself. These are not models. I here take leave of the subject.

HENRY F. CHORLEY.

Fine Arts.

ART AT LYONS.—The population of Lyons is thoroughly impressed with the immense importance of the cultivation of art in the interest of trade. The superiority of the Lyons designs, as well as of the artistic execution of those designs, has long been admitted; and the manufacturers and residents of the town and neighbourhood are indefatigable in their endeavours to maintain the reputation of the town unimpaired. The annual exhibition of works of art is the most important, after that of Paris, in all France. The artistic society of the town, besides establishing and maintaining the annual exhibition, has set on foot competitions in historical painting, the painting of flowers, drawing, the composition of ornament, engraving, and lithography. Towards the cost of these *concours*, which occur after each annual exhibition, the Emperor contributes a donation of a thousand francs; every step made in advance by the Lyonese artists being an important fact as regards the country at large. It is only by such means as this that pre-eminence in artistic manufactures is to be attained or kept.

Manufactures.

BRUSH TRADE—BRISTLES.—The demand for bristles is daily increasing, while the supply remains stationary. Any new material which will take the place of them would be a great boon to the trade. It is true that many fibres have been, from time to time, introduced into the trade, but one only is used in any large quantities, and that only for very common work. Nothing has hitherto been discovered which can be made use of as really taking the place of bristles in the manufacture of painting brushes, which require the peculiar soft termination of the bristle (technically called the "flag"), causing the brush to lay on the paint evenly.

Commerce.

BALE OF COTTON.—What is a bale of cotton is frequently asked, and the answer is not a simple one. Bales of cotton vary in their weight considerably, and the estimate in pounds depends on the source from whence it comes; thus the average weight of the Egyptian bales, the largest of all, is given by Messrs. Travers as 492 lbs.; American, 423 lbs.; Surat, 390 lbs.; Smyrna, 350 lbs.; Madras, 300 lbs.; Bengal, 300 lbs.; China, 240 lbs.; West Indian, 180 lbs.; Brazilian, 160 lbs. Now the variable amount of a bale of cotton has often led to very erroneous estimates with regard to supply and stocks, and it is much to be regretted that some permanent decision on the matter should not long before this have been arrived at by those nations the extent of whose commerce gives them or ought to give them a legitimate and preponderating influence in settling trade customs.

Colonies.

POSTAL COMMUNICATION WITH AUSTRALIA.—Negotiations are pending between several firms of the highest standing in Melbourne and Adelaide, with a view to the formation of a company to undertake the conveyance of the English mails between Galle and the Australian colonies. From the ample resources, and the peculiar facilities possessed by several of the firms, there is every reason to believe that the service could be successfully undertaken.

Obituary.

GEORGE RENNIE, F.R.S., the eminent civil engineer, died on the 30th of March, at his residence in Wilton-crescent. He was the son of an eminent father, who established an imperishable name by his great engineering works. Southwark and Waterloo bridges are among those best known to Londoners. He assisted his father in early life in the construction of the London and East India docks, the Plymouth breakwater, the construction of the Bell-rock lighthouse, &c. Mr. Rennie held the high distinction of vice-president of the Royal Society, of which scientific body he was elected a fellow in the spring of 1822. He contributed several papers to the philosophical transactions of that society. He was a member of the Royal Irish Academy, a Fellow of the Geological Society, and belonged to the Royal Academy of Turin and other foreign societies.

Notes.

AUTOGRAPHIC TELEGRAPH.—The Caselli apparatus, which remits autographic messages, has been in operation for some time between the two most important places in France, Paris and Lyons, and any person may now communicate by telegraph autographically between these places; the application of the Caselli instruments is about to be extended from Lyons to Marseilles, when the capital will be placed in direct communication with the Mediterranean. The value of such autographic messages can scarcely be said to have been established to the satisfaction of the public, but every extension and improvement in the means of communication is deserving of trial and encouragement, and it is evident that the imperial government regards the first experiment as promising, or the extension now in hand would not have been undertaken.

MEETINGS FOR THE ENSUING WEEK.

MON......Asiatic, 3.
R. United Service Inst., 8½. Mr. Michael Scott, C.E., "On Projectiles."

TUES... Medical and Chirurgical, 8½.
Civil Engineers, 8. Discussion on "The Maintenance and Renewal of Permanent Way."
Zoological, 8½.
Syro-Egyptian, 7. Annual Meeting.
Photographic, 8.
Royal Inst., 3. Prof. Frankland, F.R.S., "On the Non-Metallic Elements."
Ethnological, 8. 1. Mr. John Crawfurd, "On the Invention of Writing Materials." 2. "On an Ancient Hindu Sacrificial Bull, with inscription, found in the Northern Island of the New Zealand group."

WED ...Society of Arts, 8. Mr. E. M. Underdown, "On the Piracy of Trade Marks."
Geological, 8. 1. Mr. William Keene, "On the Brown Cannel or Petroleum Coal-seams at Colley Creek, New South Wales." 2. Rev. W. B. Clarke, "On the occurrence and geological position of Oil-bearing Rocks in New South Wales." 3. Mr. H. Bauerman, "On the Copper Mines of the State of Michigan."
Graphic, 8.
Literary Fund, 3.
R. Society of Literature, 4½.
Archæological Assoc., 8½.
Royal Inst., 3. Prof. Du Bois Reymond, "On Muscular Contraction."

THUR. ...Royal, 8½.
Antiquaries, 8½.
Royal Society Club, 6.
Royal Inst., 3. Prof. Frankland, "On the Non-Metallic Elements."

FRI ......Society of Arts, 8. Cantor Lecture. Dr. Crace Calvert, "On the Synthesis of Organic Substances." (Lecture I.)
Royal Inst., 8. Prof. Du Bois Reymond, "On the time required for the transmission of volition and sensation through the nerves."
Astronomical, 8.
R. United Service Inst., 3. Col. R. A. Shafto Adair, F.R.S., "Ireland, her Wars and Strategical History."
SAT ......R. Botanic, 3¾.
Royal Inst., 3. Mr. George Scharf, "On National Portraits."

Patents.

From Commissioners of Patents' Journal, March 30th.

GRANTS OF PROVISIONAL PROTECTION.

Air engines—684—A. V. Newton.
Artificial stone—458—F. Ransome.
Bituminous substances, distilling—756—J. F. Brinjes.
Bleaching—672—A. V. Newton.
Bolts, &c.—680—W. R. Lake.
Boring tools, holding devices for—744—T. A. Mathieson.
Boxes—802—N. Thompson.
Bracelets—762—M. Lowenstein.
Bread plates or dishes—835—J. Thompson and B. Grayson.
Brushes—805—J. Higginbottom.
Card distributor, self-acting—652—E. E. Colley and W. Moss.
Casement and other stays—784—E. Tonks.
Cast iron into steel, converting—798—J. Heaton.
Chains, &c.—632—W. B. Caulfield.
Chimnies and flues—741—S. Jakins.
Coal, mining—807—E. Beacher and J. Gillott.
Cotton, &c., sizing—674—G. Haworth, T. Parrington, and W. Hudson.
Cylinders, tools for dividing wood into—654—N. Thompson.
Diseases, prevention or cure of—169—W. Hibbert.
Disinfecting and preserving fluid—642—V. Larnaudes.
Dredging and elevating machinery—704—S. F. Schoonmaker.
Elastic gusset webs—777—J. Cole, jun.
Electricity, piles for generating—670—G. L. Leclanché.
Fabrics, finishing—833—H. Stead.
Fans or blowers—791—H. B. Barlow.
Felted cloths, bat frames used in making—751—S. Fillingham.
Fibrous materials, balling—823—B. Swain and P. Oldfield.
Fibrous materials, cleaning cotton seeds from—781—F. H. Gossage.
Fibrous materials, preparing—758—L. Kaberry.
Fibrous materials, scouring, &c.—824—T. N. Kirkham, V. F. Ensom, and H. Brook.
Fibrous substances, preparing—808—J. Campbell, S. McKinstry, and T. Wilson.
Fire-arms, breech-loading—714—C. Harvey.
Fire-arms, breech-loading, and in cartridges—688—W. Richards.
Fire-arms, breech-loading, and in cartridges for same—722—T. Restell.
Force pumps—787—T. J. Reader.
Fountains—678—E. Rimmel.
Frictional parts of machinery, covering of—813—C. S. Osborne.
Frying-pans—830—F. P. Warren.
Fulling machines—785—W. and F. Bates.
Furnaces—38—W. J. and N. A. T. Symons.
Furnaces—700—T. Prideaux.
Gas and oil, illuminating—769—G. McKenzie.
Gun and pistol barrels—822—A. R. Burr.
Hemp and flax, breaking—333—A. V. Newton.
Hollow projectiles—826—H. J. Alderson.
Impervious compounds—748—J. Macintosh.
Iron, puddling—702—J. G. Willans.
Iron ships from corrosion, protecting—774—M. J. Roberts.
Lace fabrics, ornamenting—656—C. G. Hill.
Lamp—771—E. Lichtenstadt.
Leather, finishing articles made of—746—C. Linford.
Lithographic printing, machines for—724—J. Marr.
Lithographic stones, grinding—634—W. Conisbee.
Magnetic engines—726—J. Baker.
Mathematical drawing instruments—664—W. F. Stanley.
Matters, diffusing moisture and heat through—811—E. Field and F. Lloyd.
Metallic pistons—716—T. Pattison and J. Booth.
Metal plates—517—J. Nall.
Metal provision cases, travelling knife for opening—599—R. Yeates.
Meters—733—W. C. and E. Myers.
Minerals, cutting—832—S. Dalby.
Mineral oils, distilling—827—W. E. Newton.
Motive power, obtaining—819—J. Ramsbottom.
Ordnance below water level, working—441—J. A. Longridge.
Ordnance, &c., projectiles for—636—G. P. Evelyn.
Paper bags—223—W. Clark.
Paper, pictures obtained upon—797—R. H. Ashton.
Paper, waterproof—675—R. G. Allerton.
Peat—779—T. G. Ghislin.
Phosphorus—660—J. H. Player.
Pillar cranes—825—P. G. B. Westmacott.
Pneumatic steam dredging machine—810—W. E. Gedge.
Preservative coatings—718—A. T. Machattie.
Projectiles and cartridges—834—C. E. Brooman.
Pulleys—841—H. W. Ley.
Pumps—719—E. T. Hughes.
Pumps—736—D. Gallafent.
Purple and blue colouring matters, preparing—732—G. Phillips.
Quantities and amounts, computing—770—T. Wallwork.
Railway crossings—698—W. Thomson.
Railway wheels—803—P. Michaud.
Ratchet-brace—817—W. Dicks.
Rivers, tunnelling under the beds of—770—R. Morton.
Rose engines—653—W. Clark.
Rotary brushes—620—S. and C. J. Henton.
Rotary steam engines—839—W. E. Newton.
Safes—694—G. Price.
Safes—754—J. Jessop and W. Warburton.
Safes—799—F. Hinton.
Sails, reefing of—420—J. Davidson.
Sea, saving life at—658—C. Ravelli.
Sewing machines—768—R. Gutteridge.
Sewing machines—788—A. Pilling.
Shears and scissors—795—R. Badger.
Ships' sides and bottoms, cleaning—692—W. and S. Machin.
Show cases—840—F. Sage.
Smoke, prevention or consumption of—821—W. Naylor.
Spinning and doubling—815—H. B. Barlow.
Steam boilers—794—J. Shanks.
Steam, drying—650—J. Pollit and E. Wigzell.
Steam engines—666—G. Davies.
Steam engines—708—J. B. Muschamp and J. W. Card.
Steam, superheating—682—A. C. Campbell.
Steam vessels—638—W. Clark.
Steering apparatus—626—J. Skinner.
Stoppering bottles—801—C. W. Standish.
Substances, distilling—625—J. Young.
Sugar, refining—842—E. D. Elliott.
Surfaces, laying veneers on—809—J. Chambers.
Textile fabrics, dyeing and printing—793—W. Dancer.
Twist lace machines, making lace in—776—B. W. Selby.
Two-wheel vehicles—644—J. W. Friend.
Vessels, indicating the direction of—843—S. Chatwood, and J. and T. Sturgeon.
Vessels, protecting hatchways in—712—W. Fleming.
Vices—836—G. H. Parker and H. Russell.
Wadding—686—A. Barker.
Waggons, loading—640—A. V. Newton.
Water, distributing—710—W. Russ and T. W. Wedlake.
Weaving, looms for—382—W. S. Laycock.
Weighing scales—720—E. T. Hughes.
Woven fabrics, beetling—780—W. Hutchinson and F. Jolly.
Woven fabrics, stretching—424—J. and H. Charlton.
Yarn, winding and reeling—676—J. Broadbent.

INVENTION WITH COMPLETE SPECIFICATION FILED.

Portfolios and paper files—875—G. T. Bousfield.

PATENTS SEALED.

2522. J. W. Tyler.	2547. W. B. Stocks, J. Whitwam, and W. Blakey.
2525. F. Jenner.	2549. J. Webster.
2527. S. C. Salisbury.	2553. J. Millar and B. Burton.
2528. S. C. Salisbury.	2563. R. W. Fraser.
2535. R. A. Brooman.	2571. V. J. B. Germaix.
2545. L. Hewitt.	

From Commissioners of Patents' Journal, April 3rd.

PATENTS SEALED.

542. J. and F. J. Jones.	2621. M. Henry.
2546. E. W. de Rusett & R. F. Dale.	2628. J. H. Selwyn.
2548. J. Dodge.	2629. R. Longdon.
2552. H. Hughes.	2630. A. A. Lerenard.
2555. W. R. Barker.	2638. W. Barwick.
2559. W. H. Phillips.	3647. W. Robertson & J. G. Orchar.
2564. J. Holliday.	2734. H. Newman.
2565. L. R. Whitehead.	2750. G. Haseltine.
2576. W. D. Grimshaw.	2761. G. Davies.
2577. T. Machin.	2815. S. Solomons.
2579. C. O. Crosby.	2951. A. V. Newton.
2581. H. G. Craig.	3290. J. Martin.
2596. P. Todd and J. Holding.	17. H. Hirsch.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

816. J. Musgrave.	890. J. L. Norton.
804. J. Taylor, jun.	1080. W. Rodger.
847. E. F. Clarke.	832. H. Hamer.
820. J. Carver.	845. W. H. Phillips.
825. J. Smethurst.	850. J. J. Potel.
833. J. M. Dunlop.	846. J. W. Law and J. Inglis.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

781. J. W. Kelly.	787. T. Taylor.

Registered Designs.

A Waistcoat—March 19—4780—W. Prangley, Salisbury.
The Duplex Gas Burner—4781—March 31—Thomas S. Hall, Truro, Cornwall.